Spring 5-3-2017

Extraction of Protoporphyrin IX for Use in Dye-Sensitized Solar Cells

Ken Overway  
koverway@bridgewater.edu

Carleigh Studtmann  
Bridgewater College

Follow this and additional works at: https://digitalcommons.bridgewater.edu/chemistry_faulty_scholarship

Part of the Chemistry Commons

Recommended Citation  
https://digitalcommons.bridgewater.edu/chemistry_faulty_scholarship/8

This Poster Presentation is brought to you for free and open access by the Department of Chemistry at BC Digital Commons. It has been accepted for inclusion in Chemistry Faculty Scholarship by an authorized administrator of BC Digital Commons. For more information, please contact rlowe@bridgewater.edu.
Introduction
Dye-sensitized solar cells (DSSC) are a possible alternative to traditional solar energy technologies. Metal-free organic dyes such as porphyrins seem to be an especially promising option as a sensitizer due to their characteristic Soret band and smaller Q-bands in the visible spectrum. Protoporphyrin IX (PPIX) is a naturally occurring porphyrin found in sources hemoglobin, chlorophyll, and brown egg shells. PPIX exhibits typical porphyrin absorbance spectrum, and the carboxylic acid substituents make it ideal for direct attachment to the TiO₂ of the DSSC.

The purpose of this research is to extract PPIX at a high enough concentration from brown eggshells that it could be purified using a liquid chromatography fraction collector and used as a sensitizer in a DSSC.

Experimental
Part I: Extraction
- 2M HCl and ethyl acetate added to brown egg shells until CO₂ production stopped
- Filtered using Buchner funnel, filter paper, and silica
- Organic layer separated, washed, and dried with anhydrous sodium sulfate
- Ethyl acetate solvent evaporated off of sample to calculate recovery mass of PPIX

Part II: Purification
- PPIX extract was purified on silica column using ethyl acetate mobile phase. Various other stationary phases and non-polar mobile phases were used also.
- Eluent passed through 390 µL flow cell cuvette, and the absorbance at 280 nm and 400 nm was measured on the Cary-50 spectrometer using a kinetics program.
- Absorbance spectra of the fractions that absorbed significantly at 400 nm were measured to determine if they contained PPIX.

Results and Discussion

Figure 1. Fluorescence excitation and emission spectra of the 1st PPIX extract. Inset is the spectra from Kathiravan, et al.

Figure 2. UV-vis absorbance spectrum of 2nd extract of PPIX showing the Soret band and four Q-bands.

Figure 3. The hypochromic and red-shift in the absorbance spectrum of the 2nd extract of PPIX after four days of exposure to light and oxygen. Shift is due to self-sensitized photooxidation.

• First extraction performed with 15.5 grams of brown egg shells and a recovery yield of 246 ppm
• Second extraction performed with 224.9 grams of brown egg shells and a recovery yield of 344 ppm

Conclusion
• Protoporphyrin IX was successfully extracted from brown egg shells based on the comparison of fluorescence and absorbance spectra to literature values (Figures 1 and 2).
• PPIX was partially purified from the extract, but the purification process still needs to be optimized.
• It was discovered that PPIX is highly light sensitive and thus undergoes self-sensitized photooxidation (Figure 3).

References